ECF-200W-17-0206
Revision 0

200 W Area Pump & Treat Air Emissions Modeling CY2014

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

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APPROVED
By G. E. Bratton at 12:33 pm, Oct 12, 2017

Release Approval Date

Project	200 West Area Pump and Treat CY14		
Client	PRC	Project No.	489740

Calculation Title: Air Emissions Modeling			
Calculation Identifier: 382519-CALC-053			
Role	**Printed Name**	**Signature**	**Date**
Originator	Michelle Neumann/SEA		11/18/2014
Checker	John Frohning/SEA		11/21/2014
Independent reviewer	Stacia Dugan/SEA	Stacia Dugan	12/12/2014
Approval	Rundal Fox/CHPRC		10/11/2017
Comments:			
Information Requiring Confirmation:			

Revision History

Revision Number	Description	Effective Date
A	Original Issue of document.	

1. Subject and Objective

Determine if emissions from T.O.G. stack meet compliance requirements as mentioned in the DOE/RL-2009-124 Appendix C Air Monitoring Plan. Under the C4 Monitoring section it states:

"Quarterly sampling will occur for annual determination of compliance with SQERs and ASILs. Grab samples will be collected in each stack. Additional modeling to confirm compliance with ASILs will be completed only if needed and if emissions are higher than previously calculated/modeled."

2. Methodology

Preliminary emission estimates based on source testing indicated that emissions of Carbon Tetrachloride and chloroform would exceed their applicable small quantity emission rates (SQER). Therefore, dispersion modeling would be required to demonstrate the emissions would not exceed their applicable acceptable source impact level (ASIL). The AERMOD model, version 14134, was used to calculate maximum ambient concentrations of each toxic air pollutant which exceeded the SQER. AERMOD is the US Environmental Protection Agency's (EPAs) latest generation dispersion model for calculating conservative downwind concentrations from a source of air emissions. Modeling was performed according to the procedures in 40 CFR 51 Appendix W (Guideline on Air Quality Models). Using AERMOD as a refined air dispersion model also follows Ecology's *Guidance Document on First, Second, and Third Tier Review of Toxic Air Pollution Sources*. The AERMOD model utilizes the following additional modules:

- AERMET version 14134
- AERMINUTE version 14237
- AERSURFACE version 13016
- AERMAP version 11103
- BPIPPRIM version 04274

3. Design Input

The AERMOD model source parameter input values are shown in Table 1.

TABLE 1

AERMOD SOURCE PARAMETER INPUT VALUES

Parameter	Value
Carbon Tetrachloride Emission Rate	3.31E-02 gram per second
Chloroform	5.44E-04 gram per second
Stack Height	18.54 meters
Stack Flow Rate	40,000 acfm
Stack Exhaust Velocity	17.56 meters per second
Stack Diameter	1.17 meters
Stack Exit Temperature	80 °Fahrenheit

Source: Email sent on November 12, 2014 from Richard W Oldham to Michelle Neumann

4. Assumptions

The emission rates for toxic air pollutants (TAPs) based on a weighted average of the sampling events are presented in Table 2. The samples were weighted based on the number of days until the next sampling date.

TABLE 2

TOXIC AIR POLLUTANT EMISSION RATES

Toxic Air Pollutant	02/25/14 (lb/hr)	05/13/14 (lb/hr)	08/14/14 (lb/hr)	09/04/14 (lb/hr)	09/18/14 (lb/hr)	10/08/14 (lb/hr)[1]	Weighted Average (lb/hr)	Weighted Average (lb/averaging period)	SQER
Carbon Tetrachloride	3.00E-02	3.64E-02	6.60E-01	8.53E-01	1.73E-02	1.06E-03	2.63E-01	2299.89	4.57 lb/yr
Trichloroethylene		1.25E-04					1.25E-04	1.10	95.9 lb/yr
Benzene		1.04E-03	1.50E-05		4.86E-05	6.20E-05	4.00E-04	2.55	6.62 lb/yr
Chloroform	3.26E-03	1.85E-03	2.14E-03	1.39E-02	4.40E-04		2.86E-03	37.83	8.35 lb/yr
Methylene Chloride		3.84E-05	1.19E-04		2.50E-04		1.27E-04	1.19	192.0 lb/yr
1,1 Dichloroethylene			6.22E-05				6.22E-05	1.49E-03	26.3 lb/day

NOTES:

1. When available, the 10/8/14 sample was averaged with the 09/18/14 sample before the weighted average was taken

lb/hr: Pounds per hour
lb/yr: Pounds per year
lb/day: Pounds per day

Ground-level ambient air concentrations were calculated at each receptor for the air dispersion analysis. Figure 1 displays the receptor source setup used in AERMOD. A 25-meter receptor spacing was used on the Hanford property boundary. For the major roadways crossing the Hanford property boundary (State Route 240, State Route 24, and State Route 243), a 100 meter receptor spacing was used.

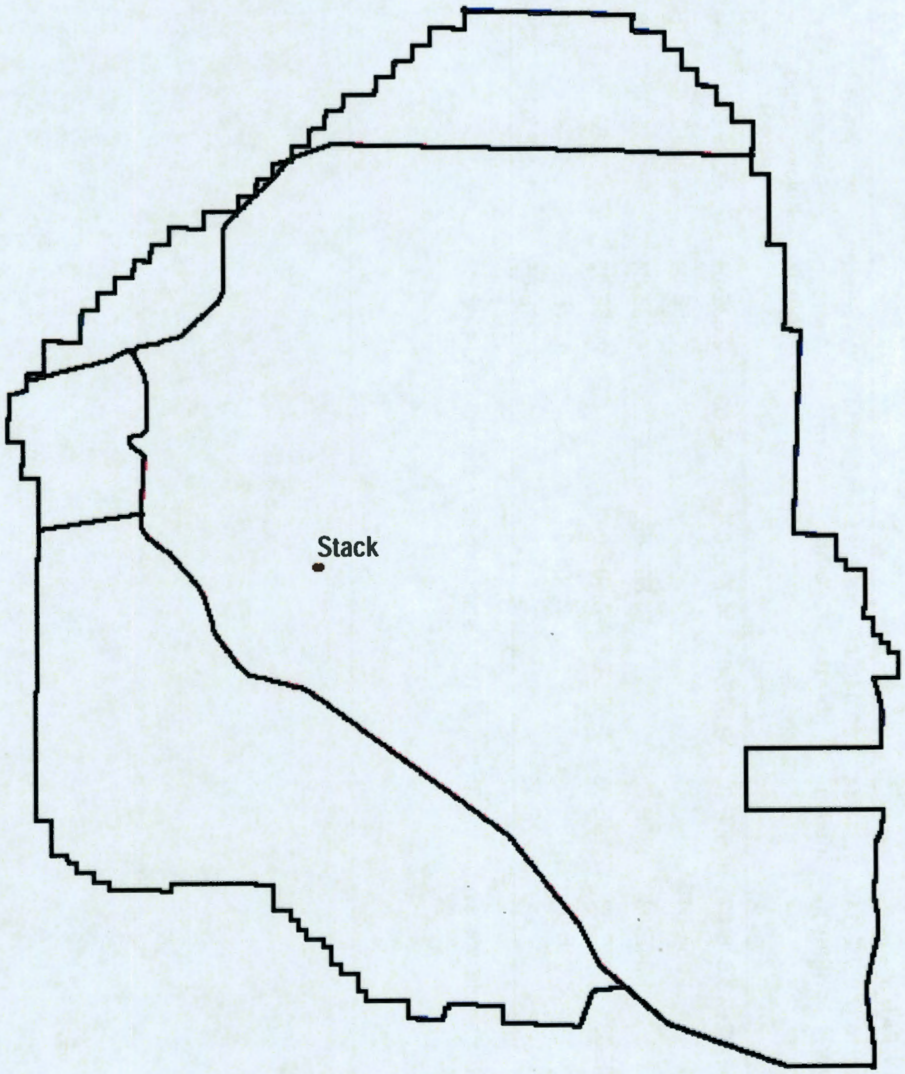

FIGURE 1 - AERMOD Receptor Locations

Plant emissions are from a single stack. Emissions were based on source testing of the unit after it was put into operation at the facility. The stack height of 18.54 meters, exit diameter of 1.17 meters, exhaust temperature of 80 degrees F, and total exhaust flow rate of 40,000 acfm were provided by the design team. The velocity was calculated based on the stack-tip diameter and flow rate.

Building downwash effects were considered. The adjacent structures were assumed to be Six Pack Tanks, the Bioprocess Building, the Rad Building, and the ERDF Container

Bay. The Six Pack Tanks and ERDF Container Bay were assumed to be 10.36 meters in height. The Bioprocess Building was assumed to be 6.2 meters in height and the Rad Building was assumed to be 7.62 meters in height.

The buildings included in the air dispersion analysis are displayed in Figure 2.

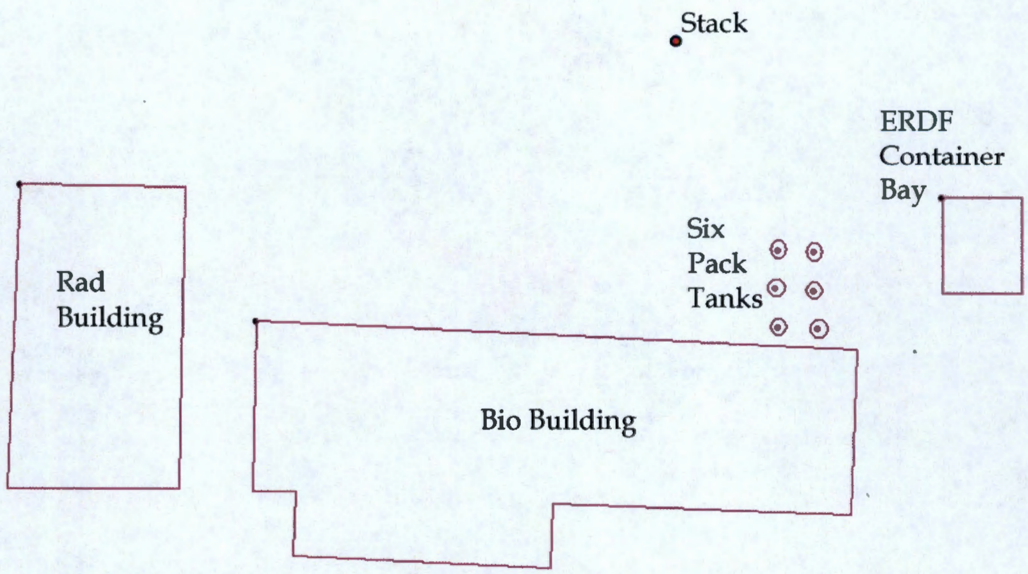

FIGURE 2 - AERMOD Building Setup

Stack, receptor, and building base elevations were calculated using AERMAP. National Elevation Data obtained from the US Geological Service (USGS) were used by AERMOD to obtain elevations and calculate controlling hill heights.

5. Meteorological Data

Surface meteorological data near Pasco, Washington were used for this modeling analysis. Surface observation data from the National Weather Service (NWS) Tri-Cities Airport Automated Surface Observing System (ASOS) station for the years 2008-2012 were utilized. The Tri-Cities airport meteorological tower is approximately 50 km southeast of the stack. No major land features separate the meteorological tower from the stack. The 1-minute wind data from this ASOS station were processed with AERMINUTE and supplemented into the surface data. This surface dataset was then processed in conjunction with concurrent twice daily upper air data collected at the NWS Spokane, Washington observation station using the AERMET preprocessor. Additionally, surface characteristics utilized in AERMET for the area surrounding the Grant County airport meteorological tower were determined with the AERSURFACE preprocessor using U.S. Geological Survey (USGS) National Land Cover Data. A wind rose of the AERMET processed data for is displayed in Figure 3.

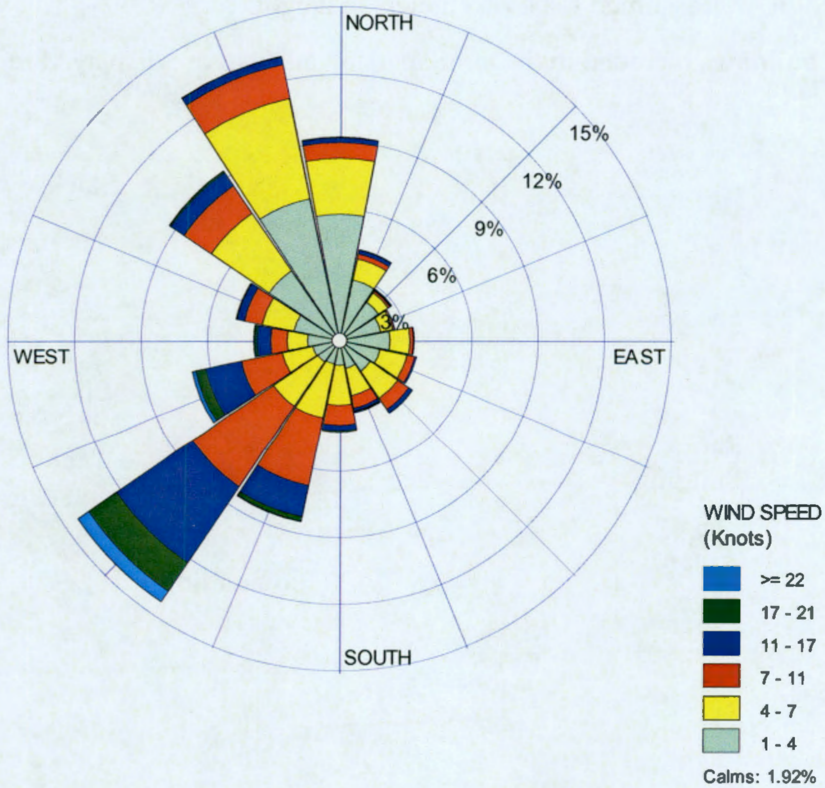

FIGURE 3 - AERMET Processed Wind Rose

6. Results

Compliance with the Air Monitoring Plan was demonstrated. First the potential emissions are compared to the small quantity emission rate (SQER) for each toxic air pollutant and applicable averaging period. If the potential emissions are lower than the SQER, no further air quality impact analysis would be required under the regulation.

If the emissions are above the SQER, an ambient air quality modeling analysis is required. As shown in Table 3 two TAPs have emission rates exceeding the respective SQERs; they are carbon tetrachloride, and chloroform.

TABLE 3

COMPARISON OF EMISSIONS TO SQER

Pollutant	Average Emission Rate (lb/hr)	Averaging Period	SQER (lb/year)	Emission Rate (lb/year)	Modeling Required?

TABLE 3

COMPARISON OF EMISSIONS TO SQER

Pollutant	Average Emission Rate (lb/hr)	Averaging Period	SQER (lb/year)	Emission Rate (lb/year)	Modeling Required?
Carbon Tetrachloride	4.57E-02	year	4.57	2,300	**YES**
Chloroform	2.86E-03	year	8.35	37.83	**YES**

Table 4 presents the AERMOD model results at the maximum impacted receptor compared to the applicable thresholds. Model results demonstrate carbon tetrachloride and chloroform concentrations would not exceed their applicable ASIL and the project would comply with the Air Monitoring Plan.

TABLE 4

COMPARISON OF CONCENTRATIONS TO ASIL

Pollutant	Annual Average Concentration (μg/m³)	Annual ASIL(μg/m³)
Carbon Tetrachloride	0.00201	0.0238
Chloroform	3.31E-05	0.0435

Utilizing the above AERMOD modeled results, emissions were back calculated to determine emissions corresponding to 95 percent of the ASIL. Table 5 presents the emissions resulting in 95 percentile of the ASIL impacts. That is, if emissions are less than the values presented below in Table 5, resultant impacts would be below the ASIL.

TABLE 5

EMISSIONS FOR 95% OF ASIL IMPACTS

Pollutant	Annual ASIL(μg/m³)	95% of Annual ASIL(μg/m³)	Maximum Emission Rate (lb/yr)	Emission Rate (g/s)
Carbon Tetrachloride	**0.0238**	0.0226	25,816	3.71E-01
Chloroform	**0.0435**	0.0413	47,185	6.79E-01

7. Calculations

As mentioned in the *AERMOD: Description of Model Formulation* (EPA, 2004), AERMOD utilizes the Gaussian dispersion equation for estimating horizontal and vertical distribution for stable boundary layer condition and horizontal distribution for the convective boundary layer condition. A bi-Gaussian with probability density function dispersion is used for the vertical distribution for convective boundary layer condition. Plume rise follows the Weil formula for stable boundary layer condition and Briggs formula for the convective boundary layer condition.

The basic equation (equation 67 in the Formulation Document) for concentrations in the stable boundary layer condition is:

$$C_s\{x_r, y_r, z\} = \frac{Q}{\sqrt{2\pi}\tilde{u}\sigma_{zs}} \cdot F_y \cdot \sum_{m=-\infty}^{\infty}\left[\exp\left(-\frac{(z-h_{es}-2mz_{ieff})^2}{2\sigma_{zs}^2}\right)+\exp\left(-\frac{(z+h_{es}+2mz_{ieff})^2}{2\sigma_{zs}^2}\right)\right]$$

Where:

C_s: total concentration (SBL) (g/m³)
Q: source emission rate (g/s)
$\tilde{u}$: wind speed at stack top (m/s)
σ_{zs}: total vertical dispersion (m)
F_y: total horizontal distribution function with meander (1/m)
z: height of receptor in horizontal plume state/ terrain-following state (m)
h_{es}: plume height (m)
$2m$: two meters
z_{ieff}: height of reflecting surface (m)

The basic equation for concentration in the convective boundary layer is composed of the sum of three components, concentration contribution from the direct source, concentration contribution from the penetrated source, and concentration contribution from the indirect source. The equation is as follows (equations 59, 65, and 66 in the Formulation Document):

$$\begin{aligned}C_c\{x_r, y_r, z\} = &\left(\frac{Qf_p}{\sqrt{2\pi}\tilde{u}} \cdot F_y \cdot \sum_{j=1}^{2}\sum_{m=0}^{\infty}\frac{\lambda_j}{\sigma_{zj}}\left[\exp\left(-\frac{(z-\Psi_{dj}-2mz_i)^2}{2\sigma_{zj}^2}\right)+\exp\left(-\frac{(z+\Psi_{dj}+2mz_i)^2}{2\sigma_{zj}^2}\right)\right]\right)\\ &+\left(\frac{Qf_p}{\sqrt{2\pi}\tilde{u}} \cdot F_y \cdot \sum_{j=1}^{2}\sum_{m=1}^{\infty}\frac{\lambda_j}{\sigma_{zj}}\left[\exp\left(-\frac{(z+\Psi_{rj}-2mz_i)^2}{2\sigma_{zj}^2}\right)+\exp\left(-\frac{(z-\Psi_{rj}+2mz_i)^2}{2\sigma_{zj}^2}\right)\right]\right)\\ &+\left(\frac{Q(1-f_p)}{\sqrt{2\pi}\tilde{u}\sigma_{zp}} \cdot F_y \cdot \sum_{m=-\infty}^{\infty}\left[\exp\left(-\frac{(z-h_{ep}+2mz_{ieff})^2}{2\sigma_{zp}^2}\right)+\exp\left(-\frac{(z+h_{ep}+2mz_{ieff})^2}{2\sigma_{zp}^2}\right)\right]\right)\end{aligned}$$

Where

C_c: total concentration (CBL) (g/m^3)
Q: source emission rate (g/s)
f_p: fraction of plume mass
$\tilde{u}$: wind speed at stack top (m/s)
F_y: total horizontal distribution function with meander (1/m)
λ_j: weighting coefficient for the updraft and downdraft distributions
z: height of receptor in horizontal plume state/ terrain-following state (m)
Ψ_{dj}: total height of the direct source plume (m)
2m: two meters
z_i: mixing height (m)
σ_{zj}: total vertical dispersion for the updrafts and downdrafts for both direct and indirect sources (m)
Ψ_{rj}: total height of the indirect source plume (m)
h_{ep}: penetrated source plume height above stack base (m)
σ_{zp}: total dispersion of for the penetrated source (m)
z_{ieff}: height of the upper reflecting surface in a stable layer (m)

8. List of Attachments

Attachment A – AERMOD and AERMET modeling files

9. Computer Program Information

AERMOD version 14134, AERMET version 14134, AERMINUTE version 14237, AERSURFACE version 13016, AERMAP version 11103, and BPIPPRIM version 04274.

10. References

EPA, 2004: AERMOD: Description of Model Formulation. EPA-454/R-03-004. Office of Air Quality Planning and Standards Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina 27711.

Department of Ecology State of Washington, 2013: Guidance Document: First, Second and Third Tier Review of Toxic Air Pollution Sources. Chapter 173-460 WAC. Air Quality Program, Olympia, Washington 98054.

ATTACHMENT A

AERMOD & AERMET Modeling Files